Reauthorization of the Clean Water Act: Important Issues for Water Quality Scientists

Patrick L. Brezonik and **William Cooper**
University of Minnesota and Michigan State University

Introduction: An Unfinished Agenda

Whether one considers the 1972 Clean Water Act (CWA) to be revolutionary in its approach to water quality policy and management in the United States or merely a defining statement based on policies that already had evolved, few would dispute the Act's overall significance. Its implementation has had profound impacts on state and federal regulatory programs related to water quality and on funding for construction of treatment plants, planning, research and training. Similarly, there can be little doubt that it has had a major beneficial impact on the quality of the nation's aquatic resources, regardless of concerns and doubts about its economic efficiency and overall benefit-cost ratio.

Nonetheless, legislation that may have been appropriate for the water quality issues and national needs that existed more than two decades ago is not necessarily adequate for the issues and needs that dominate present conditions. In spite of laudable attempts within the CWA framework to address nonpoint pollution concerns (e.g. through the areawide 208 planning process), the fact remains that much less progress was made over the past 20 years in controlling nonpoint pollution sources than in controlling point sources. It is widely agreed that nonpoint sources of pollution now account for the great majority of degraded surface waters. Finally, although the CWA has done much to stem the trend of declining conditions in the nation's surface waters, much remains to be accomplished to restore their quality and integrity.

It is perhaps a historical simplification, but the driving issues when the CWA was passed in 1972 were related primarily to human health and human use of surface waters (thus the goal to make all waters "fishable and swimmable"). The pollutants of primary concern were the conventional ones in municipal wastewater (organic matter, suspended solids, microbial pathogens, nutrients), and the pollution sources of greatest concern were municipal and industrial waste effluents, of which many then received little or inadequate treatment. In contrast, the driving water quality issues of the 1990s are focused more on the fuzzy concept of ecosystem health and integrated management of water quality on a watershed basis; the pollutants of primary concern are synthetic organic compounds and selected heavy metals, which may be toxic to aquatic organisms as well as humans; and the primary uncontrolled sources of these contaminants are urban and agricultural stormwater runoff and medium- to long-range atmospheric transport of emissions from widely distributed sources.

Of course, this greatly different national perspective on critical issues did not occur suddenly in the past year or two; instead, there has been a gradual evolution toward the present issues over the past 20 years, as the most serious problems of the 1970s and 1980s were recognized and addressed. Similarly, the CWA has not been a static piece of legislation but has evolved over the past 20 years as the result of several major reauthorizations, minor additions and amendments. As noted in several papers elsewhere in this issue of *WRU*, even the name "Clean Water Act" was not applied to the legislation in an official sense until the 1977 reauthorization. As is true of most complicated and precedent-setting legislation, the initial act proved to be unworkable in some respects and did not address a number of problems that later were found to be important. Major modifications were made to the CWA in the reauthorizations of 1977 and 1987; smaller changes were initiated by amendments passed in 1982. The modifications passed in 1977 and 1987 focused increasing attention on toxic pollutants, especially synthetic organic compounds. The amendments of the 1980s de-emphasized the construction grant program, culminating in its replacement by a state revolving fund for construction loans in 1987.

Perspectives on Reauthorization: The Forum of Scientists

As Congress again has faced reauthorization of the CWA since 1992, scientists, other interested parties, and policy makers have reviewed the successes and shortcomings of the existing legislation. A variety of controversial issues have been raised; many of the underlying principles of federal/state programs and policies developed within the existing Act have been questioned; and major redesigns of the legislation have been proposed. It seems quite possible that the current reauthorization exercise will modify the CWA in ways that will impact water quality management in the United States over the next 20 years as profoundly as the original Act did over the past 20 years.

Other papers in this issue of *WRU* describe a variety of perspectives regarding desirable features of a reauthorized CWA (e.g. the perspectives of state water quality agencies, agricultural scientists, economists and educators). In this paper we present some perspectives and recommendations of water quality scientists. These are based primarily on the results of a forum of 16 scientists convened by the second

author at the request of the administrator of the U.S. EPA in February 1991. Scientists attending the forum were asked to consider how reauthorization of the CWA could be used to address the "remaining environmental problems critical to long-term economic, ecological, and human health components of our quality of life". The forum resulted in a report to the administrator (Cooper, 1991) that identified and ranked the most important environmental risks associated with our aquatic ecosystems and made specific suggestions as to how scientists would address these problems.

General Recommendations

The issues and recommendations resulting from the forum can be grouped into four broad categories: generic issues (not pollutant or program specific); nutrients and hazardous chemicals; habitat alteration and loss; and infrastructure and institutions. The complete set of recommendations are too numerous to describe here in their entirety, and the following discussion is based on our subjective selection of some of the most important issues and recommendations.

In general, the forum concluded that the 1972 CWA did a good job of protecting our water resources for issues of primary interest in the 1970s, but combined sewer overflows and persistent toxic substances remain priority concerns. Other significant risks still exist because the source of stress was addressed inadequately or not at all or was explicitly exempt in the initial act. Agricultural policies and practices, habitat destruction, and the introduction of exotic species were considered to be the most important new issues that must be incorporated into the reauthorization. The forum also recommended that the CWA must recognize the dependency of sustainable economic development and public health on self-sustaining aquatic ecosystems; thus the CWA must be broadened to incorporate ecological as well as public health dimensions. At the same time, some aspects of its focus on protection of public health must be strengthened. In particular, the CWA must provide the same status for protection of drinking water supplies as it does for protection of fish, wildlife, and recreation.

Today scientists realize even more than they did in the past that prevention of physical alterations to aquatic habitats and management of terrestrial portions of watersheds are essential elements of any long-term program to maintain or improve aquatic ecosystem integrity. Forum scientists concluded that the title and goals of the Clean Water Act do not encompass these critical areas and recommended that the act be retitled along the lines "Aquatic Resources Protection Act" or Clean and Habitable Water Resources Act". Regardless of the name given to the Act, the philosophy implicit in the suggested names needs to become a paradigm for future programs operated under the Act.

Toxic Pollutants

Much of the current concern about clean water issues is related to contamination by potentially toxic compounds — primarily synthetic organic chemicals, especially chlorinated compounds (various pesticides, PCBs, dioxins, various solvents), but also certain heavy metals such as cadmium, lead, and mercury. The present list of Toxic ("Priority") Pollutants in section 307 of the Act was developed by a Congressional committee in 1977. It forms the basis for extensive regulatory, monitoring and treatment activities, but the list of chemicals never was subjected to scientific review. A similar situation applies to the list of Hazardous Substances in Section 311 of the Act. Although provisions exist for the administrator of EPA to revise the Toxic Pollutants list, this has been done only rarely. Some of the present listings are environmentally insignificant, analytically ambiguous, or have never been produced commercially. The result is that valuable resources are misspent monitoring and treating some compounds that pose negligible risks instead of focusing those resources on compounds with more substantial risks. The Section 307 and 311 lists should be subjected to public comment and review; additions to or deletions from the current lists should be based on scientific peer review.

Aside from the appropriateness of the priority pollutant and hazardous substance lists, several generic problems need to be addressed regarding potentially toxic chemicals. First, our ability to detect such compounds has far outstripped our ability to evaluate the risks that such compounds pose at low concentrations. At present, we are able to measure only rather major effects associated with highly contaminated areas. Although the mere presence of a toxic chemical or even its uptake by organisms does not automatically mean that deleterious biological effects are occurring, neither does the absence of obvious problems constitute proof that no deleterious effects are occurring. The reauthorized CWA needs to make a long-term commitment to fund focused research that will develop a sound scientific information base for rational management of contaminants. In particular, research needs to be funded that: (1) relates the extent and duration of chemical exposure in key biological species to significant biological effects; (2) develops a suite of indices (bio-indicators or bio-markers) that link contaminant exposure or body burdens to key biological processes such as reproduction and resistance to disease; and (3) develops an understanding of how and at what levels complex mixtures of contaminants produce sublethal effects.

Monitoring and Modeling

A well-designed, long-term water quality monitoring program is essential for sound water quality management. Monitoring provides basic information on the status and trends of water quality in the nation's aquatic ecosystems as well as feedback on the effectiveness of pollution

abatement efforts. Although millions of dollars are spent annually to monitor water quality, the nation's water monitoring programs are highly fragmented, and there are serious concerns about the effectiveness (benefit/cost ratio) of these programs. According to an estimate by the Intergovernmental Task Force on Monitoring Water Quality (ITFM, 1992), over $70 million was spent on federal and state programs to monitor ambient water quality in 1990, and about two-thirds of that amount was federal money. Monitoring activities are widely dispersed among numerous federal, state, and local government agencies, and there currently is little coordination among these programs.

The Clean Water Act mandates the states to conduct monitoring and assessment programs on their water resources, and through Section 305b of the Act, the U.S. EPA provides grant funds to the states to conduct such ambient monitoring efforts. The EPA estimates that states spent about $12 million in federal grant money and perhaps twice that much in state funds for this purpose in 1990 (U.S. EPA, 1991). At first glance, this total appears to be a significant financial commitment, but divided among 50 states, the average per state (~$700 thousand per year) is not particularly impressive. Moreover, there are several flaws with the design on the current 305b monitoring program; it is not a well-coordinated program with an overall national plan or design. For example, sampling stations on rivers frequently are located downstream of point sources. Such stations provides useful data for "compliance monitoring" purposes but not for extrapolation to conditions over a broader reach. In addition, there are wide differences among states in the design of their monitoring programs (frequency of sample collection, number of sites monitored, parameters measured, etc.). Sampling of the same sites (especially lakes) is not always consistent from year to year, and this makes the establishment of temporal trends problematic. These problems greatly reduce the usefulness of 305b monitoring efforts in making national assessments of status and trends in water quality.

In recent years, two large federal monitoring programs have been developed (in part) to overcome the deficiencies of the 305b monitoring efforts: the National Water Quality Assessment (NAWQA) program of the USGS and the Environmental Monitoring and Assessment Program (EMAP) of the EPA. Neither program has been fully implemented to date, but funding levels for each already are in the same range as the total spent by states (with federal assistance) in their ambient water quality monitoring programs. There seems to be little coordination among these three monitoring programs (305b, NAWQA, and EMAP). Given the generally similar goals of the programs, the significant amounts of federal dollars spent by each, and the possibilities for improved efficiency and effectiveness that a more coordinated effort could produce, this lack of coordination is indeed unfortunate. We believe it would be appropriate for Congress to mandate better organization (tighter coordination) of state ambient monitoring efforts conducted under the auspices of the 305b program, as well as improved coordination with the federal monitoring programs described above.

Finally, monitoring programs are most likely to be effective and efficient when they are designed within the framework of a conceptual model for the ecosystems being monitored and when they are question-driven (i.e. designed to answer specific questions). Too often, purposes of collecting monitoring data are not well defined and much of the data simply is filed away and not used. At the same time, when modelers attempt to parameterize or calibrate water quality models using ambient monitoring data, they often find that the data are unsuitable to the requirements of their models. In general, monitoring and modeling efforts should be designed in concert. Modeling should precede monitoring, and then monitoring should be defined relative to the models. Although the predictive value of models is open to question (Oreskes et al., 1994), models can and should be used to aid in the assessments that monitoring programs ultimately were established to perform. As assessments proceed, both the monitoring and modeling efforts should be adjusted to optimize responsiveness to the requirements of the problem.

Funding Issues

Aside from the research needs for toxic contaminants described in a preceding section, there are significant needs for research funding related to integrated ecosystem risk assessment and integrated ecosystem management. In addition, federal funding has almost disappeared for research to improve waste treatment technologies. Although the goal of pollution prevention is laudable and should be pursued vigorously, problems of "residuals management", production of waste streams, and treatment or removal of contaminants from water will be with us for the foreseeable future. Furthermore, there is no reason to believe that waste treatment technology has reached its zenith and that further advances are unlikely.

On the contrary, exciting possibilities exist for more effective and efficient treatment technologies based on improvements in such fields as membrane technology, semiconductor photochemistry, and biotechnology. Although private industry and municipal wastewater treatment utilities have an important role to play in fostering such research (see article by Reinhardt, this issue), the catalytic role of stable federal funding is difficult to overstate. It is truly unfortunate that the federal government has almost completely abdicated its responsibilities in this area over the past decade.

An even broader issue is that of unfunded federal mandates to states. For the past decade or longer, there has been a trend for Congress to issue new mandates to the states

concerning water quality protection but not provide the financial or program support to carry out these mandates. The federal government must increase its participation in funding new water quality programs that it mandates.

Congress should consider creating a federal "Aquafund" analogous to Superfund to clean up critical, high-risk areas of contaminated or degraded surface waters. Similarly, the time is past for merely talking about restoring the nation's aquatic ecosystems — the vast number of lakes, rivers and streams, and wetlands that we have degraded by our irresponsible behavior of the past. The need for restoration exits; public support is there; an agenda and timetable have been proposed (NRC, 1992). Congress should establish a restoration of aquatic ecosystems program as part of the reauthorized CWA. Like the current Clean Lakes Program, this program should require substantial state and local co-funding of restoration projects. It is to be hoped, however, that the new program would be unlike the Clean Lakes Program in funding and administration support; the CLA always has been poorly funded and has struggled for survival within unsympathetic administrations for years (see article by Lapensee, this issue).

Agriculture

The forum was unanimous in recognizing that agricultural and silvicultural practices are major sources of nutrient and soil erosion problems in the nation's surface waters. It also concluded that educational efforts and demonstration systems to promote voluntary action have met with little success. (This is view probably is not shared widely within the agricultural community; see Swader, this issue.) The forum recommended that restrictions be placed on agricultural and silvicultural practices to assure protection and enhancement of water quality by linking these practices to other federal programs. For example, crop subsidy payments or approval of "below cost" timber sales could be linked to approval of farm management or timber harvest plans that assure protection and enhancement of water quality. Forum scientists also recommended that agribusiness operations should be regulated by discharge permits, if necessary, and should be required to monitor surface and groundwater associated with their operations (as are nonagricultural businesses). Finally, the reauthorized CWA should provide adequate funding support for state and local agencies to implement nonpoint source control activities in the new federal statutes.

Many improvements in agricultural practices can be made by using "carrots" rather than "sticks": conservation reserve programs have been successful in removing marginal lands from production, and changing the crop subsidy system to discourage planting of row crops right up to the banks of ditches and streams also has helped. Site-specific technology can be developed to minimize soil erosion and also to help farmers determine the precise fertilizer requirements of their soil. A wide range of "best management practices" (BMPs) has been developed and these are an obvious first approach to solving agricultural nonpoint source pollution problems. By themselves, BMPs may not be sufficient, however, and economic incentives, coupled with mandatory requirements, should be considered where necessary.

Habitat and Species Losses

Human activities have caused dramatic adverse impacts on the physical habitat and biotic composition of the nation's surface waters. The problems stem from two sources: (1) widespread physical destruction of habitat by such causes as soil erosion, deforestation, urban development, improper construction and management of dams, drainage of wetlands and channelization of natural streams; and (2) chemical destruction of habitat caused by excessive use of pesticides and nutrients that accumulate in aquatic ecosystems and lead to changes in species composition and diversity.

Americans have been sensitized to the problem of biodiversity losses caused by chemical uses through 30 years of "education" by environmental action groups and environmental scientists. (Rachel Carson's book, *Silent Spring*, considered by many to be the harbinger of the environmental movement, was published in 1962.) Curiously, we are much less sensitized to the damage wrought by physical destruction of habitat — perhaps because many of us still view actions like wetland drainage for subdivision development and stream channelization for flood control as inevitable events in our taming of the American wilderness, signs of our primacy over nature, or slightly unfortunate events for "nature" that nonetheless benefit our personal lifestyles.

If we thought that the solutions to chemical destruction of aquatic ecosystems were difficult and controversial, wait until we get serious about the problems of physical destruction of habitat! In general, solutions to chemical problems simply cost money; serious attention to habitat destruction rapidly starts to get into intensely controversial questions of individual property rights versus government-imposed limitations on those rights for a supposed common good. For reasons of historical development, Americans appear to have a unique perspective among the world's developed, industrial nations about the primacy of individual owners to decide how to use their land. This was a luxury we could afford without serious (or at least disastrous) repercussions while we were a sparsely settled land, but it is unlikely that we will be able to maintain this perspective as the population density of many states and regions approaches that of western Europe.

The forum of scientists recommended a range of solutions to the problem of habitat destruction, and not all of them are highly controversial. Overall, forum scientists

concluded that effective management must occur at the watershed level and must include erosion control and protection of riparian zones. Specific recommendations include adding provisions to the CWA to restrict federal actions that cause habitat destruction by controlling subsidies, encouraging federal purchase of critical habitats, and providing funds to states for habitat preservation. A more controversial recommendation of the forum involves the Section 404 program. Widely perceived to be a wetlands protection program, it primarily is a water quality provision that regulates discharge of fill material into wetlands. The forum recommends that the section be broadened to regulate dredging and drainage activities.

Concluding Comments

With a look to the future, it is interesting to consider three trends: (1) the proportion of the U.S. population involved in agricultural pursuits has continued to decline throughout this century and probably will continue to do so for some decades; (2) gains in agricultural productivity over the past 20-30 years have decreased the amount of land needed to grow the food we need; (3) similar gains in productivity globally have somewhat diminished the importance of U.S. agriculture as a source of food for overpopulated countries; and (4) overall, the fraction of the U.S. economy that is related to agricultural activities probably is lower now than at any time in our history. These considerations lead us to suggest that agricultural problems (including physical destruction of habitat and use of fertilizer and pesticides) may not dominate CWA reauthorization issues 20 years hence.

We are less sanguine about the prospects of controlling aquatic habitat destruction caused by urban and suburban development and by our burgeoning desire for a second home in what is often the most sensitive area of a watershed (waterfront property). Most likely, the chemical impacts of low-quality stormwater runoff from these areas will continue to worsen. It seems likely that increasingly intractable problems from urban and suburban sprawl will be the contentious issues of the CWA reauthorization debate in 2012-2015.

References

Cooper, W. 1991. Report from the Forum of Scientists: Reauthorization of the Clean Water Act. Rept. of the Administrator of the U.S. EPA, Inst. for Environmental Toxicology, Michigan State Univ., East Lansing, MI, 62 p.

Intergovernmental Task Force on Monitoring Water Quality (ITFM). 1992. Ambient water-quality monitoring in the United States. First year review, evaluation and recommendations. Report to Off. of Management and Budget, Washington, D.C., 51 p. (Available from USGS, Office of Water Data Coordination, Reston, VA)

National Research Council. 1992. *Restoration of Aquatic Ecosystems*. National Academy Press, Washington, D.C., 552 p.

Oreskes, N., K. Shrader-Frechette, and K. Belitz. 1994. Verification, validation and confirmation of numerical models in the earth sciences. Science 261: 641-646.

U.S. Environmental Protection Agency, 1991. Design report for EMAP. Office of Research and Development, EPA/600/3-91/053, Washington, D.C., 33 p.

Patrick Brezonik is a professor in the Department of Civil Engineering at the University of Minnesota in Minneapolis and director of the University's Water Resources Research Center. William Cooper is professor in the Institute for Environmental Toxicology at Michigan State University in East Lansing, Michigan.